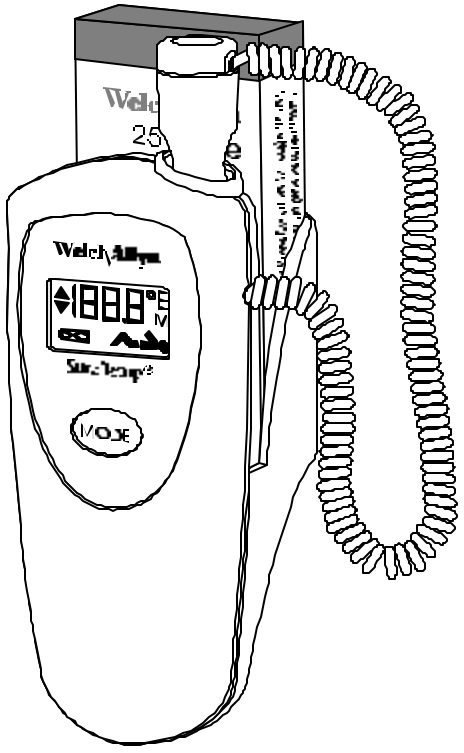
Thermo Menu

Operator Manual

Service Manual

SureTemp®

Model 986 Thermometer



Welch Allyn, Inc.
7420 Carroll Road
San Diego, CA 92121

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1. General Information

1.1 About the Model 986

The Welch Allyn Model 986 SureTemp is a portable, predictive thermometer that accurately measures body temperatures in a few seconds at oral, axillary, or rectal sites. Oral/axillary and rectal probes utilize single use disposable probe covers to help limit cross-contamination.

This instrument was developed for use by medical professionals and day care providers. The predictive technology allows the user to take oral temperatures in approximately four seconds, axillary temperatures in approximately 10 seconds (for children under four years), and rectal temperatures in approximately 15 seconds.

1.1.1 System Block Diagram

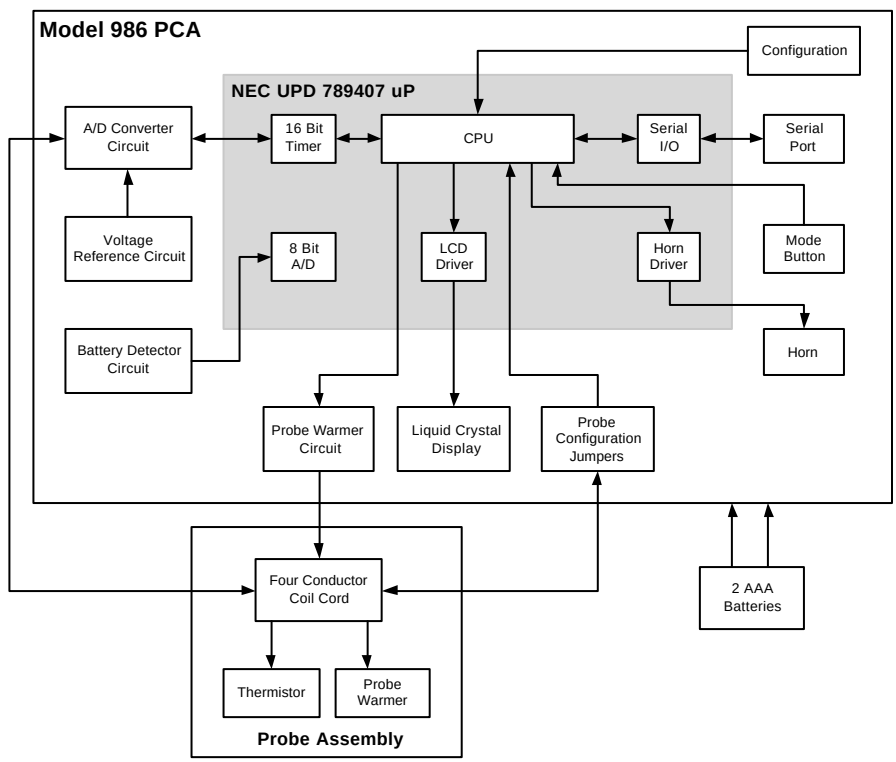

Figure 1: System Block Diagram

1.2 Technical Support

Contact Welch Allyn Customer Service at:

Welch Allyn, Inc
7420 Carroll Road
San Diego, CA 92121

800-535-6663

1.3 Safety Warnings and Notices

1. DO NOT USE THIS INSTRUMENT IN THE PRESENCE OF FLAMMABLE ANESTHETICS.
2. Do not use this instrument for any purpose other than those specified in the User's Guide. Doing so will invalidate the instrument's warranty.
3. Oral/Axillary SureTemp thermometer models (with a blue ejection button at the top of the probe) are to be used for taking oral and axillary temperatures only. Rectal models (red ejection button) are to be used for taking rectal temperatures only. Use of a probe at the wrong type of site will result in temperature errors.
4. Use only single-use Welch Allyn disposable probe covers. The use of any other probe cover or the failure to use a probe cover may produce temperature measurement errors and increase the chances for cross-contamination.
5. The thermometer case is not waterproof. Do not immerse it in liquids or drip fluids onto it.
6. Dispose of batteries in accordance with all local, state and federal environmental guidelines.
7. This instrument consists of high quality precision parts and should be protected from severe impact and shock. Do not use the thermometer if you notice any signs of damage to the probe or instrument. Contact Welch Allyn Customer Service at (800) 535-6663 for immediate assistance.

Note: This thermometer complies with current required standards for electromagnetic interference and should not present a problem to other equipment or be affected by other devices. As a precaution, avoid using this device in close proximity to other equipment.

1.4 Classifications

Type of protection against electric shock	Internally Powered Equipment
Degree of protection against electric shock	Type BF Applied Part
Degree of protection against ingress of liquids	Ordinary (IPXO)
Degree of safety in the presence of flammable anesthetics	Equipment not suitable for use with flammable anesthetics
Mode of operation	Continuous

1.5 About this Manual

This manual describes both the Model 986 Oral/Axillary and Rectal thermometers. Most topics and procedures are equally applicable to both products. Where there are differences, we will note which instrument is being discussed.

1.5.1 Related Documents

End user operation of the Model 986 is covered in the M986 User Guide and Quick Reference Guide.

Model 986 User Guide	70994-1000
Model 986 Quick Reference Guide	71019-0000

This Service Manual assumes that the technician understands these operations.

1.6 Return Procedure

Contact Welch Allyn Customer Service at (800) 535-6663 *before* returning an M986 Thermometer to the factory for service.

1.7 Terms used in this Manual

The following abbreviations are used in this manual:

Main Component Terms	
PCB	Printed circuit board (the board itself)
PCA	Printed circuit assembly (with all components)
LCD	Liquid Crystal Display
BATT.	Battery.
DMM	Digital Multi-Meter
O-Scope	Oscilloscope
Component Reference Terms	
C	Capacitor
D	Diode
E	Test point
J	Connector jack
L	Inductor
LS1	Horn
P	Connector plug
Q	Transistor
R	Resistor
S	Switch
U	Integrated circuit
X	Crystal, resonator

2. Service

2.1 Basic Operation of the Model 986

The Model 986 is a portable digital thermometer. Service technicians should check the basic operation of the instrument before it is disassembled.

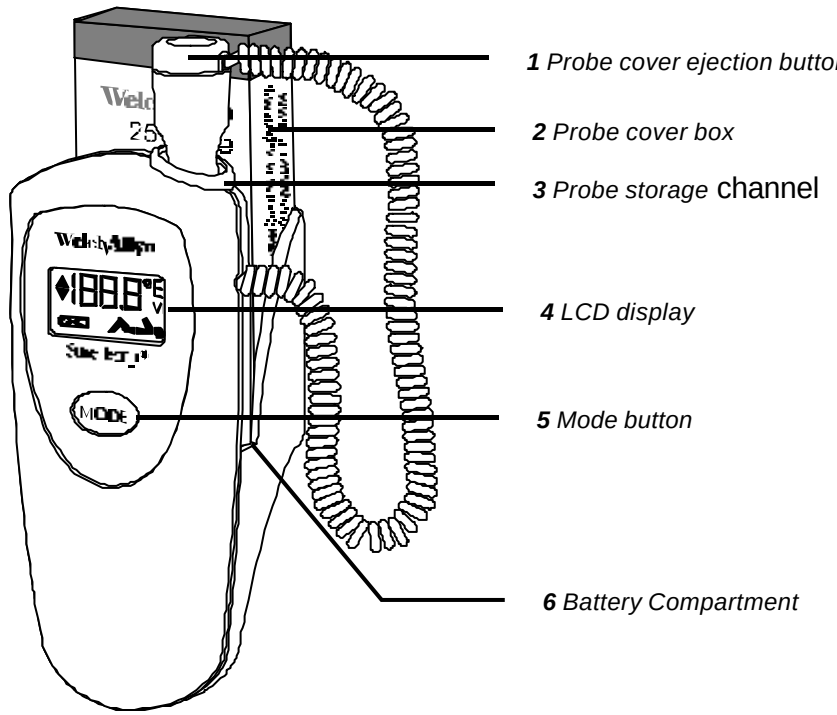

Figure 2: Model 986 Thermometer

2.1.1 Types of units

The M986 is available from the factory in the following configurations:

- Oral /Axillary or Rectal Probe
- ° F/°C, ° F Only, °C Only

Note: Thermometer configuration *cannot* be modified in the field.

2.1.2 Major Thermometer Components

Batteries The Model 986 thermometer uses two standard disposable alkaline AAA cells. These batteries provide long life for reduced down time. No battery charging is required or possible.

Probe Two types of probes are available: Oral/Axillary (blue), and Rectal (red). The probe is *not* detachable and is connected to the printed circuit board at the factory.

Probe Covers The probe covers are unchanged from previous models and are compatible across all of Welch Allyn's thermistor-based thermometers.

Note: The use of probe covers other than Welch Allyn PN 05031 is not allowed, and will affect the accuracy of the instrument.

2.1.3 Instrument Reset

If a problem is reported with an instrument, please check its operation *before* resetting it.

Reset Procedure

1. Remove the batteries from the instrument (see page 15).
2. After battery removal, any remaining charge due to internal capacitance must be discharged to achieve a proper reset. After the batteries are removed, press the **Mode** button for about five seconds. The electronics will now properly reset when the batteries are replaced.
3. Reinstall the batteries. Watch the display and observe the power up self-test (page 7).

2.1.4 POST (Power Up Self-Test)

The self-test includes a series of internal microprocessor self tests, instrument electronics tests, and the display test. If there are internal electronics problems detected by the self-tests, the **Err** (error) icon will be displayed and an audible tone will sound. Refer to the Error Codes table in the Troubleshooting section (page 19) for an explanation of any error code. The M986 electronics are tested each time the batteries are replaced.

- The Power up test begins with all display segments and icons simultaneously illuminated, followed by a display of the software revision in this instrument. The M986 beeper also briefly sounds at the beginning of the test.

Figure 3: M986 Display

- At the end of the test, the display goes blank and the unit is ready to operate.

If there is no display, any missing segments, or no beeper, refer to the Troubleshooting table (page 22).

2.1.5 Probe Type Test

Test the probe to make sure that the correct type of probe is attached to the unit.

With the probe shaft in the probe well and the display blank, press the **Mode** button for three seconds. After three seconds, the instrument will beep and the display shows the icon with the measuring site blinking.

- For a blue (oral/axillary) probe, either the head or arm should blink, depending on whether the instrument is configured for Oral or Axillary measurements.
- With a red (rectal) probe, the leg icon should blink.

If the wrong icon is blinking, there is a problem with either the probe or the probe type configuration in the instrument.

1. Refer to the mode table on the schematic diagram (*Appendix D*).
2. In the mode table, locate the type of instrument – oral only, rectal only, etc. that you are using.
3. Open the thermometer and locate the jumpers. Verify that the jumpers are configured for your type of unit.
4. If the jumpers are not configured properly, contact Welch Allyn Customer service for assistance.

2.1.6 Operational Checks

Normal Mode

Normal mode operation is the rapid mode of temperature taking. This is the default mode and is automatically selected when the probe is withdrawn from the probe well.

1. When the probe is withdrawn from its storage well, every segment on the display will be illuminated. Watch for the display to change from the all segments test to the body icon display.
2. When the unit is ready, it will beep. The °F or °C symbol (whichever is selected) will illuminate, and the measuring site (oral, axillary, rectal) will begin to blink.
3. Load the probe cover at this time. The instrument is now ready for the probe to be placed in the measuring site.

Note: It is possible that the display will switch from the measuring site display to the “walking segments” display and back again several times before the probe is inserted in the site. This is acceptable operation and will not adversely affect the temperature taken.

Monitor Mode

The thermometer will automatically switch to Monitor Mode under certain conditions:

- If the instrument determines that room temperature is above 33.9°C (93.0°F).
- If the thermometer is unable to predict a temperature, after 15 seconds for Oral/Axillary and 30 seconds for rectal, due to improper technique such as excessive probe movement at any patient site (i.e. mouth, rectum, axillary).

Note: The thermometer reads the probe temperature immediately upon removal from the storage well. If the probe was just replaced from a previous temperature and immediately extracted, insufficient time may have passed to allow the probe to cool to room temperature. This will cause the instrument to determine room temperature to be higher than actual. The instrument will switch to Monitor mode immediately if it detects room temperature to be above 33.9 °C (93.0°F). *For best results, the user should wait at least 30 seconds between Normal mode temperature measurements.*

If Monitor mode does not display expected temperatures, refer to the Troubleshooting table on page 22.

Temperature Display

With correct use, the patient's temperature will be displayed in about four seconds in oral mode, about 10 seconds in axillary mode, and about 15 seconds with a rectal probe. The instrument will beep to signal completion of the Normal Mode temperature cycle.

Automatic Shutoff

If the probe is left out of the storage well after completion of a Normal mode temperature, the unit will shut off automatically after 10 seconds to conserve power. Simply replace the probe in the storage well to prepare for the next temperature.

The instrument will shut off automatically if the probe temperature remains below 28.9°C (84.0°F) for more than 30 seconds.

Peak Monitor Mode

Peak Monitor mode allows long term monitoring of a patient's peak temperature. Unlike predictive mode, Peak Monitor mode will follow a temperature as it rises and display this temperature until the probe detects a higher temperature. When this occurs, the higher temperature is displayed.

Peak Monitor mode provides a direct readout of the peak probe temperature. The instrument can set in Peak Monitor mode by immediately pressing the **Mode** button for two seconds after a predictive (normal) temperature has been taken.

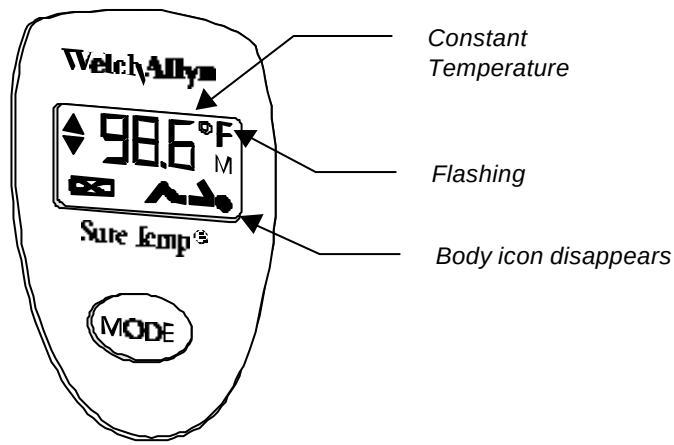

Figure 4: Peak Monitor Mode

Peak Monitor mode will be indicated on the display by a continuous temperature reading with a blinking **°F** or **°C** Icon at the upper right corner of the LCD, and by the body icon disappearing.

The typical slow rise in temperature when Peak Monitor mode is used is due mainly to the mouth temperature slowly recovering from placement of the colder (room temperature) probe. The probe itself is actually very fast at rising to the temperature of its surroundings, usually reaching it within a few seconds. Because of this slow mouth recovery, three minutes is the recommended time to wait before recording a Peak Monitor mode temperature.

Peak Monitor mode is also useful in testing the accuracy of the thermometer when the probe can be warmed to a known temperature, as with a Welch Allyn Model 9600 Calibration Tester or in a water bath (see section 2.4).

In Peak Monitor mode, after approximately 60 seconds of *no increase* in temperature, the **°C** / **°F** icon stops flashing. You will hear two triple beep sounds, and the peak temperature will be displayed on the LCD.

Note: If the unit is left in Peak Monitor Mode for a total of five minutes, it will automatically shut off to conserve power.

If Peak Monitor mode does not display expected temperatures, refer to the Troubleshooting table on page 22.

°F / °C Conversion

When a final temperature is displayed (in Normal, Recall, or Monitor mode), press and release the **Mode** button to toggle the temperature between °F/°C.

Note: A recalled temperature will be displayed in whichever scale (°F/°C) is selected at the time of recall. This setting can be changed during display.

If pressing the **Mode** button does not change the scale of the displayed temperature, refer to Mode Button Problems in the Troubleshooting table on page 22.

Temperature Recall

With the instrument in low-power mode (sleep mode or blank display), press and release the **Mode** button to cause the most recent measured temperature to be displayed for five seconds. The stored temperature value appears with a °F or °C symbol (whichever is selected) and an M indicating it is from memory.

- If the recalled temperature was a *normal mode* temperature, the flashing symbol of the measurement site is also displayed.
- If the recalled temperature was a *Peak Monitor* temperature, only the temperature is displayed, with no site indicated.

Activation of the probe well switch (place the probe in the well) will interrupt the temperature recall function.

Temperature recall problems

If the last temperature cannot be recalled, refer to Temperature Recall Problems in the Troubleshooting table on page 22.

If pressing the **Mode** button does not change the scale of the displayed temperature, refer to Mode Button problems in the Troubleshooting table.

2.1.7 Default algorithm for oral and axillary modes (blue probe)

Two predictive algorithms are available: oral and axillary. To change the default algorithm:

1. Place the unit in low power mode.
2. Press and hold the **Mode** button for at least two seconds, until a short beep is heard. The current algorithm will be displayed.
3. To advance to the next algorithm, press the **Mode** button momentarily.

Note: When replacing the batteries, the default power up setting is the oral predictive algorithm.

2.2 Service Procedures

2.2.1 List of Tools and Equipment

Most service operations can be performed with standard tools and test meters:

- A #1 Phillips screwdriver can be used for all instrument screws.
- A standard lab 3.5 digit digital multi-meter (DMM) will provide sufficient accuracy for most tests. A needle-tipped pair of probes is recommended. An oscilloscope is sometimes the only way to analyze high speed signals, but is not generally required.
- Standard electronics tools and supplies for small surface-mounted and through-hole component rework will be needed to perform any electronics repairs. Some surface-mounted components are extremely small and present a challenge for rework by hand. A light touch, tweezers, sharp soldering iron tip, and low heat (#7 tip) are recommended.
- Power (+) and ground (-) are available at the battery terminals.
- Be sure to service the instrument in an ESD-safe work area.

2.2.2 Preventative maintenance

Units that are used on a regular basis should have the following preventative maintenance performed at least every six months:

1. Visually inspect the thermometer for physical damage that might cause future product failure.
2. Clean the unit per the instructions in the User Guide supplied with the thermometer and/or per the instructions below.
3. Perform the Power on Self Test (page 7), Startup Display Test (page 7), and the Calibration Test procedure (page 16).

Long Term Storage

Remove the batteries from units that are to be stored for an extended period and not used.

Regular Tests and Calibration

Perform the following tests every 12 months regardless of storage and usage levels:

1. Replace the batteries (page 15).
2. Perform the Power on Self Test (page 7), Startup Display Test (page 7), and the Calibration Test procedure (page 16).

2.2.3 Cleaning and Sterilization

Routine Cleaning

Clean the exterior of the Model 986 and the probe as needed.

- Use a Q-Tip to clean the probe well.
- Wipe all surfaces with a clean cloth dampened with warm water and a mild detergent, alcohol, or a nonstaining disinfectant such as Sporicidin® Spray[1] and Towelettes cleanser.

Care should be taken not to scratch the LCD faceplate. Make sure that the cloth is damp, but not too wet.

- Do not allow cleaning solution to flow inside the instrument.
- Never immerse the thermometer into the cleaning solution.
- Never autoclave the thermometer or probe.

Gas Sterilization

When no other form of decontamination such as a germicidal wipe is acceptable, a low temperature (not to exceed 48.9°C or 120°F) ETO gas sterilization cycle may be used. Refer to your institution's standard operating procedure for the length of the cycle.

Note: Gas sterilization may cause some hazing of glossy plastic surfaces and should be used only when absolutely necessary.

1. Remove the probe from its storage well and disconnect it from the instrument.
2. Remove any probe covers from the probe and from the probe cover storage well.
3. Remove the batteries following the instructions on page 15.

   WARNING: Leaving batteries in the thermometer during the sterilization procedure may present an explosion hazard.

4. Wrap the thermometer in standard sterilization packaging such as the Baxter Tower Dualpeel Sterilization Pouch.
5. ETO gas sterilize the instrument at a temperature not to exceed 48.9°C (120°F) and aerate.
6. Remove the sterilization packaging.
7. Allow the probe and instrument to stabilize to room temperature for at least one hour before reinstalling the batteries and probe.

[1] Sporicidin is a registered trademark of Sporicidin International (800) 424-3733.

8. Reinstall the batteries (see page 15) and verify a successful self-test.
9. Reinstall the probe connector and insert the probe into the storage well to start the probe initialization process.
10. Verify proper calibration of the thermometer and probe using the Welch Allyn Model 9600 Calibration Tester.

2.2.4 Service Activities

Field Service Repairs

Repairs are considered field serviceable if the repair will not alter the calibration or proper operation of the instrument. Recalibration requires a computer-based system and is normally performed at the factory.

Factory Repairs

Because of programming requirements, if problems are traced to microcontroller U1, the unit must be returned to the factory or properly equipped service center for repair.

2.2.5 Component Replacement

All components in the Model 986 can be replaced without affecting instrument operation or calibration. Changing R13 will cause some minor changes to the exact calibration point, but as long as the proper type and tolerance resistors are used (0.05%, as supplied by Welch Allyn), the unit will remain within specifications.

LCD Frame Repair or Replacement

Replacement of the LCD frame is somewhat difficult due to the need to assemble it while under pressure to assure proper compression of the elastomeric connector.

Note: Do not glue the LCD frame to the display PCB if the frame pins are broken. This will destroy the display PCB. Replace the LCD frame with a new LCD frame.

2.3 Battery Removal and Replacement

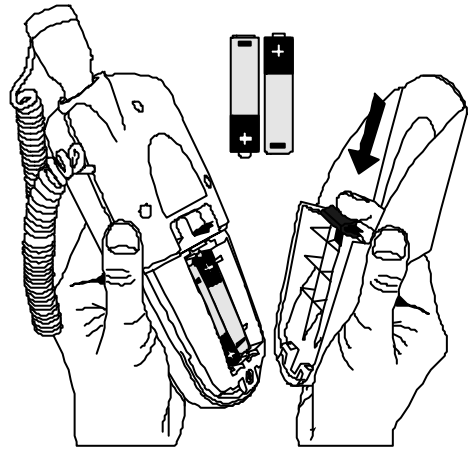

Figure 5: Battery Removal and Replacement

1. Remove the Probe Cover box holder on the back of the instrument by pressing with your index finger on the latch located on the rear of the Probe Cover box holder.
2. Remove the batteries.
3. Press the **Mode** button for approximately five seconds to discharge the electronics.
4. Install two new AAA, alkaline batteries according to the battery polarities marked inside the battery compartment. Verify that the thermometer completes a power on reset test (page 7), and then goes blank.

   CAUTION: Incorrect battery polarity may result in damage to the thermometer.

5. Snap the probe cover storage assembly in place by inserting the bottom tabs first and then snapping the latch on top.

2.3.1 Battery Life

Under normal use, battery life will provide approximately 3,000 normal temperature measurements, based on an average 22.2°C (72.0°F) ambient temperature. Colder ambient temperatures, excessive peak monitor measurements, and other usage patterns can reduce battery life.

Instruments are shipped with fresh batteries, but we cannot guarantee full life from the first set of batteries due to potential long storage times between shipping and actual use. Battery life can also be reduced by storage at elevated temperatures.

If you are experiencing short battery life, refer to Battery Life Problems in the Troubleshooting table on page 22.

2.4 Calibration Procedures

2.4.1 Calibration Limits Table

Patient Temperature	
Oral/Axillary	35.5° C to 43.0° C (96° F to 109.4° F)
Rectal	30.0°C to 43.0° C (86° F to 109.4° F)
Ambient Temperature Range	9.0° C to 40.0° C (48.2° F to 104.0° F)
Laboratory Accuracy	± 0.1° C (± 0.2° F) in the Monitor Mode In a water bath, must meet ASTM E1112-86 and EN12470-3 Standards
Battery Operating Life	Approximately 3,000 normal mode measurements at 22.2°C (72° F) ambient temperature

2.4.2 Water Bath procedure

The target patient temperature for the M986 ranges from 96° F to 109.4°.

1. Adjust the water bath to 109.6°F. Apply a probe cover to the thermometer probe, and let the probe tip sit in the water bath.
2. Place the thermometer in Peak Monitor Mode (page 9). Wait three minutes. Verify that the water bath temperature is displayed on the LCD with the up arrow flashing.
3. For temperatures below the minimum target temperature, verify that the minimum temperature is displayed on the LCD, and the down arrow is flashing.

2.4.3 Variable Temperature Water Bath procedure

Adjust the water bath to 46.0°F. Apply a probe cover to the thermometer probe, and let the probe sit in the water bath for one minute.

1. Press and release the **Mode** button. Verify that a Low Ambient error (E1.2) occurs, but that a probe A/D pulse width error (E0.2) does NOT occur.
2. Repeat with the water bath set to 106.0°F, and verify that a High Ambient error (E1.1) occurs, but that a probe A/D pulse width error (E0.2) does NOT occur.

2.4.4 Model 9600 Calibration procedure

The Model 9600 Calibration Tester provides a convenient means of testing the entire thermometer system (instrument and probe).

- The 9600 must be warmed up and stable at one of the two available temperature settings: 106º F/41º C or 96.4º F/35.8º C.
- The instrument under test must be in Peak Monitor mode (page 9) with no probe cover loaded.

The probe is inserted into the small hole in the dry heat well of the Model 9600 and allowed to settle for a minimum of two minutes at the final temperature. The reading on the thermometer must be within the range specified on the Model 9600. Refer to the Model 9600 Operation Manual for complete instructions.

Note: All Welch Allyn thermometers, (thermistor and infrared ear thermometers) can be checked in the Model 9600.

If you are having problems with the use of the Model 9600, refer to the Troubleshooting section in the Model 9600 Operation Manual.

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3. Troubleshooting

Many operational parameters of the thermometer can be tested before the unit is taken apart.

- Refer to *Operational Checks* (section 2.1.6) and *Error Recall Mode* (section 3.1.2) to complete preliminary checks.
- If the trouble seems to be calibration related, refer to *Calibration Testing* (page 16).

If these operational tests do not resolve the problem and you are sure that the instrument is not performing properly, use the following sections to complete the debugging process. Be sure to have the proper tools and equipment (page 11).

3.1 Error Codes

Errors can fall into three categories: Transitory, Recoverable and Non-Recoverable.

Transitory

Transitory errors are generated by external events, not by the thermometer. Temperature measuring will be inhibited until the error is cleared. There is no limit to the number of times a transitory error can occur.

Note: All probe problems are considered by the thermometer to be external events and are therefore classified as transitory.

Recoverable

Recoverable errors are generated from internal test failures. These are non-catastrophic, but they prevent temperature measurement until the error is cleared.

After displaying an error code, the instrument will reset itself and attempt to resume normal operation. After the fourth attempt to clear itself, the error becomes non-recoverable.

Non-Recoverable

Non-recoverable errors are generated from internal test failures that are catastrophic (or from promoted recoverable errors). The error code will be stored in memory and the LCD will display **Err**.

The only way to continue at this point is to reset the electronics by removing the batteries.

3.1.1 Types of Errors

There are three types of recoverable and non-recoverable errors, and each type of error has a unique display that will last about five seconds before the unit goes into Low Power Mode (blank display).

Ambient Error — The Operating Temperature is out of limits. An Ambient Temperature Too High error display (E1.1) shows a © flashing two times per second, together with an **A** and the **°F** or **°C** icon.

An Ambient temperature Too Low error (E1.2) display shows a ™ flashing two times per second, together with an **A** and the **°F** or **°C** icon.

Battery Error — The display shows a non-flashing battery icon, with no other LCD icons visible.

Instrument Error — The display shows a non-flashing **Err** in the lower numeric LCD digits, with no other LCD icons.

Each error type can be viewed using the Error Recall Mode (Section 3.1.2).

Table 1: Self-Test Error Table

Error	Class	Description	Action
E0.1	Instrument	Probe heater energy accumulator test.	Contact Welch Allyn
E0.2	Instrument	Probe A/D pulse width test.	Contact Welch Allyn
E1.1	Ambient	Ambient temperature high test.	Move unit to lower ambient temperature area and retry
E1.2	Ambient	Ambient temperature low test.	Move unit to a higher ambient temperature area and retry
E2.1	Battery	“Dead” battery test.	Replace batteries
E3.1	Instrument	RAM error	Contact Welch Allyn
E4.1	Instrument	Ratio Cal resistor A/D pulse width test.	Contact Welch Allyn
E5.0	Instrument	Heater circuit test.	
E5.1	Instrument	Heater overheated test.	
E5.2	Instrument	Heater hardware watchdog time out test.	Contact Welch Allyn
E5.3	Instrument	No Probe Heater	Try a different probe, then contact Welch Allyn
E5.7	Instrument	Data Overrun test	Contact Welch Allyn
E5.8	Instrument	Stack Overflow test	Contact Welch Allyn

3.1.2 Error Recall Mode

The M986 has the ability to recall the most recent error condition from memory.

To enter this program mode:

1. Place the unit in low power (sleep) mode by allowing it to rest for about 30 seconds. The display will go blank.
2. Press and hold the **Mode** button and, at the same time, remove the probe from the probe well. In this mode the M986 will display the letter “E” followed by an error code. (for example, E0.1)

   If the **E** is not followed by an error number, the instrument has not had any errors since its last power-on reset (Battery replacement).

The instrument exits Error Recall mode automatically after five seconds. Replacing the probe in the probe holder returns the unit to normal operation.

If you cannot enter the Error Recall Mode, refer to Error Recall Mode Problems in the Troubleshooting table on page 22.

3.2 Troubleshooting Table

If the unit fails to operate properly after completing the suggested procedure listed in the following table, contact Welch Allyn Customer Service at 1-800-535-6663.

Symptom	Possible Cause	Procedure
No operation	Dead batteries, no batteries, battery missing, battery incorrectly installed	Refer to Battery Removal and Replacement section on page 15. Check that all batteries are installed in proper direction. Reset electronics. (See Instrument Reset/Self Tests section on page 6)
	Broken battery wire	Open instrument case, install batteries, check for voltage on main PCB at battery wire connections.
	Short circuit preventing operation	Remove batteries, press mode button 5 seconds, set DMM to Ohms, measure resistance of electronics at battery contacts (“+” to bottom right corner, “-” to top left corner) Resistance should climb to more than 2 Mega ohms as C25 charges.
	Failed component	Check oscillator at U1-68 for 2.4975 MHz sine wave. If not present, suspect X1, U1, C6, and C7.
Display problems	LCD frame loose	Check that all 3 plastic hooks for the LCD frame are tight and not broken. The frame should not be lifting off of PCB.
	Dirty LCD elastomeric conductor strips	Remove LCD frame by unlatching plastic hooks. Clean LCD elastomeric strips, LCD glass contacts, and PCB contacts with lint proof cloth dampened with alcohol.
	Failed Component	Check R17 for open component
	Cracked LCD	Inspect LCD for hairline cracks
Display problems (Continued)	Microprocessor failure	Check for improper soldering of pins, crystal operation on O-scope, proper reset.
No beeper sound	Defective horn	Replace horn.
	Broken connection	Check continuity from U1-50. to horn pin 2 and from ground to horn pin 1.
	Defective U1	Check for signal with O-scope at U1-50. Replace microcontroller U1.
Normal/Monitor Mode switching problems	Ambient above 33.9°C (93.0°F)	Will cause auto switch to Monitor mode.

Symptom	Possible Cause	Procedure
	Switched to Monitor mode before probe in mouth	If probe is still cooling from a previous temperature and used immediately, it might sense ambient to be above 33.9°C (93.0°F).
Probe: Wrong type displayed	Missing one or more configuration Jumpers JP1-JP4	Check that the configuration Jumpers are installed according to the Probe Type truth table.
Battery Life Problems	Excessive alarms Excessive use in monitor mode	The horn draws significant current. During monitor mode the instrument is continuously drawing current.
	Dead cell	If cell voltage is down significantly in only one cell, this battery is defective. All batteries are drained at the same rate by the instrument.
	First Set Shelf Life	Due to possibly long stocking times between fabrication and end use, the first set of batteries may have reduced life.
Monitor mode temperature reading too low	Probe or Instrument malfunction	Test calibration of thermometer with the M9600 Calibration Tester
	Improper placement of probe	Probe must be under the tongue and as far back as possible into the sublingual pocket.
	Temperature not stable	Allow three minutes for Monitor mode reading to stabilize in mouth.
Monitor mode temperature reading too high	Probe or Instrument malfunction	Test calibration of thermometer with the M9600 Calibration Tester.
Normal mode temperature reading too low	Instrument malfunction	Test calibration of thermometer with the M9600 Calibration Tester.
	Improper placement of probe	Probe must be under the tongue and as far back as possible into the sublingual pocket.
Normal mode temperature reading too high	Probe or Instrument malfunction	Test calibration of thermometer with the M9600 Calibration Tester.
	Improper technique	Movement in mouth after insertion and before final temperature is displayed can cause high readings. Place probe quickly into sublingual pocket and hold still.
	Improper technique	Do not place probe in mouth until display is showing the body icon.

3.3 Disassembly/Reassembly

Refer to section 1.3 and review all safety warnings before attempting to disassemble the Model 986.

3.4 Field Serviceable Parts

3.4.1 Main Components

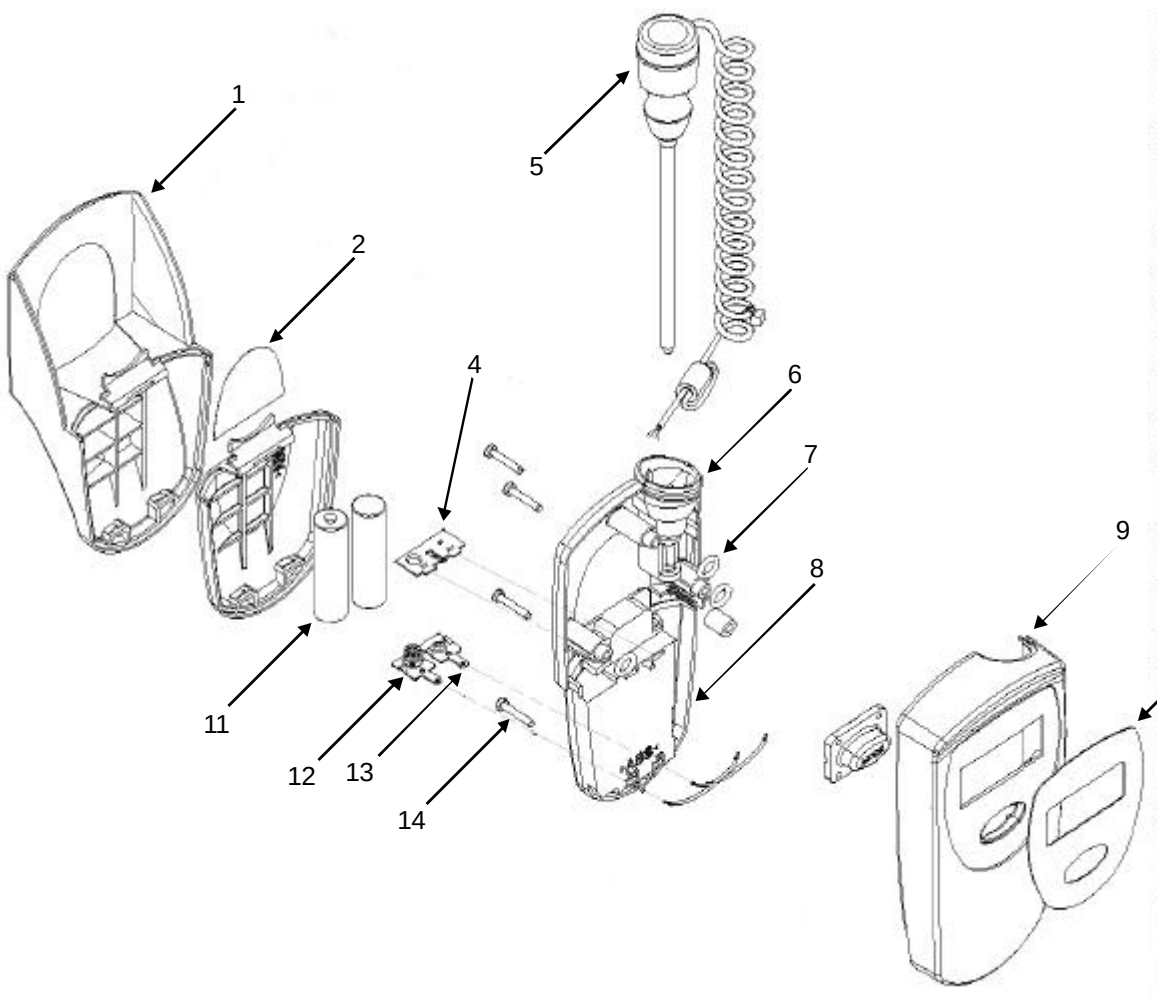

Figure 6: Thermometer Assembly

Note: All parts are serviceable by qualified technicians. Please refer to Table 2 to check the part number for the items shown on this diagram.

Table 2: Main Components

Dwg Item	Part #	Description
8	21288-XXXX	Printed Circuit Assembly
9	25245-0000	HSG, Front
6	25246-0000	HSG, Rear
1	25248-0000	HSG, Probe Cover
3	25249-0000	HSG, Battery
	25244-0000	Frame, LCD
5	02986-000	ASSY, Probe, Oral
	60028-0000	LCD, 2V
	58582-0000	ZEBRA Strip LCD Connector
	58577-0000	Horn
	25247-0000	Switch Mode
4	58578-0000	Contact, Pos/Neg
12	58579-0000	Contact, Pos.
13	58580-0000	Contact, Neg
11	53009-000	Batteries AAA Alkaline (2)
	80128-0000	Tubing, Silicone
14	83174-0000	Screws (4)
7	85259-0000	O-Rings (3)
	85257-0001	Die Cut Foam
	70994-0000	User's Manual
2	70855-0000	S/N Tracking Label
10	71004-0001	Front Label
	75063-101	Probe Covers

3.4.2 Model 986 PCA

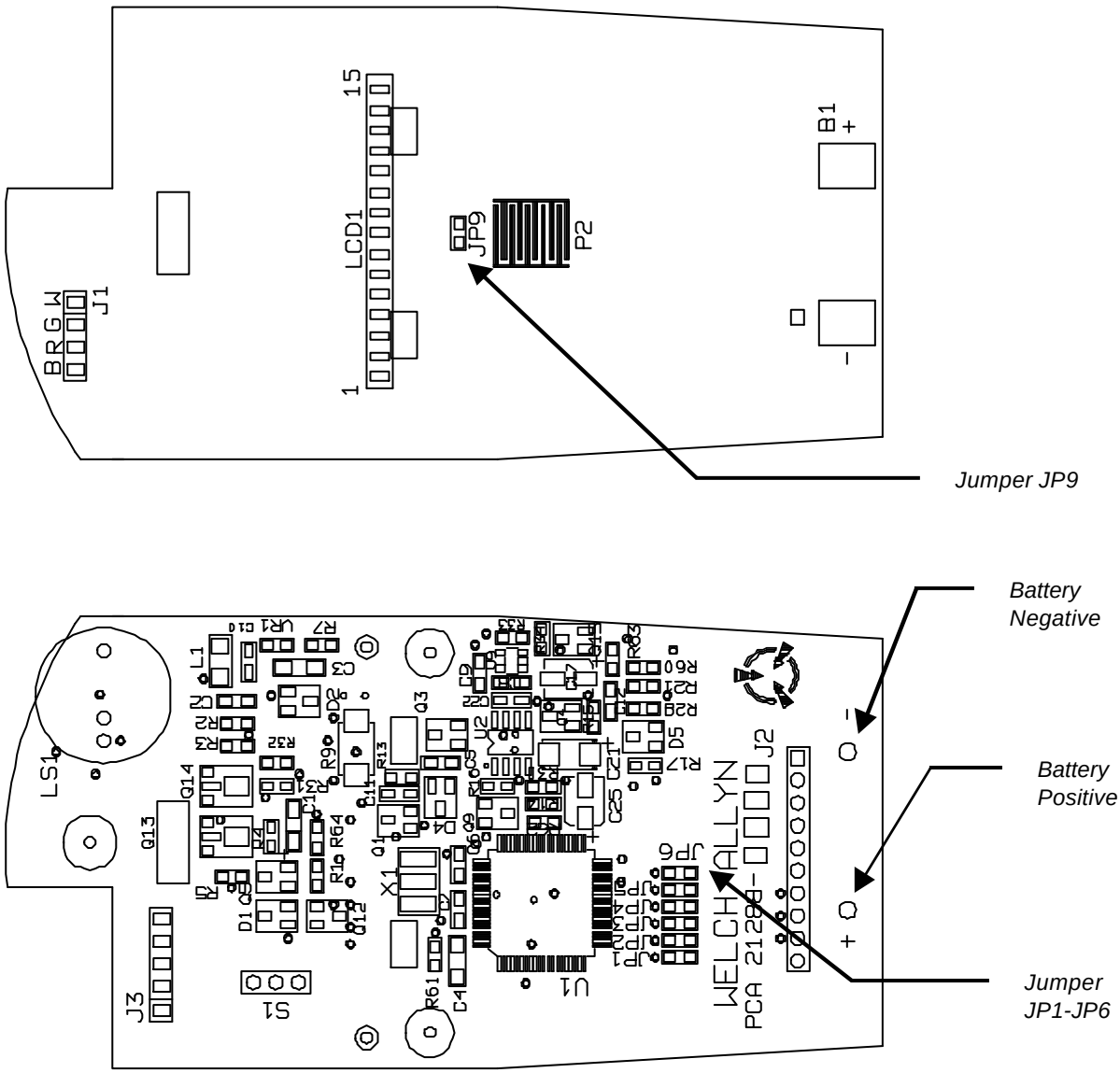

Figure 7: Printed Circuit Assembly

3.4.3 Replacement Parts for PCA

Table 3: Replacement Parts for PCA

Part Number	Reference #	Description	Qty/Per	UOM
21288-0011		PC ASSY. MAIN, M986	1	EA
56142-0000		PC BOARD,MAIN,M986	1	EA
40290-0000	JP1, JP2, JP3,JP4	RES, 0 OHM, 5%, 0805 SIZE	6	EA
	JP5, JP6,R62,R63			
40290-1020	R5, R16, R31, R32	RES 1K, 5% 0805 SIZE	4	EA
40290-1030	R21, R30	RES 10K, 5% 0805 SIZE	2	EA
40290-1040	R7	RES 100K SM 5% 0805 SIZE	1	EA
40290-4720	R2, R14, R15, R17	RES 4.7K SM 5% 0805 SIZE	4	EA
40290-4730	R3, R4, R61	RES 47K S, 5% 0805 SIZE	4	EA
40301-2420	R28	RES 12.4K SM .1% 0805 SIZE	1	EA
40320-0000	R13	RES, 11.55K, 0.05% 25PPM	1	EA
40322-0000	R1	RES,SMD,3M,1/10W,5%,0805	1	EA
40315-1120	R33	RESISTOR,23.68K,5%,0805	1	EA
40312-3720	R34	RESISTOR,51.1K,5%,0805	1	EA
43010-0000	L1	INDUCTOR 10UH LOWRES CHIP	1	EA
44047-0000	D1, D2, D4	DIODE, DUAL, MMBD1203	3	EA
44048-0000	D5	DIODE,BAT54,SOT23	1	EA
46022-000	C3, C4	CAP 0.1UF 50V +80%-20% Z5	2	EA
46127-1030	C2, C5, C8, C9,	CAP 0.01UF 100V X7R CHIP	7	EA
	C10, C12, C22			
46129-1050	C1	CAP 1UF TANTCHIP 16V +/-20%	1	EA
46136-0000	C21	CAP, .33UF, 10%, 50V TANT	1	EA
46137-0000	C25	CAP, CHIP, 1UF, 20%, 50V	1	EA
46138-0000	C17	CAP, 10UF, 20%, 16V ALUM	1	EA
46140-0000	C6, C7	CAP, CHIP, 22PF, 5%, 50V	2	EA
50029-0000	Q9	TRANS XX2222A NPN SOT-23	1	EA
50030-0000	Q4, Q5	TRANS XX5087 PNP SOT-23	2	EA
50031-0000	Q13, Q14	TRANS BCX69 PNP SOT-89	2	EA
50032-0000	Q1, Q3	TRANS BSS138 FET, SOT-23	2	EA
50035-0000	Q12, Q15	TRANSISTOR, PNP W/BIAS RE	2	EA
54277-0000	U2	IC, TIMER, 1.5V,LMC555CM	1	EA
54278-0001	U1	IC, ASSSY, MICROCONTROLLER	1	EA
54279-0000	U9	IC, VOLT RGLTR,SOT-23	1	EA
58540-0000	S1	SWITCH PROBE, M986	1	EA
58577-0000	HORN	SPEAKER, MINI, PIEZO ELECT,	1	EA

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Appendix A. Theory of Operation

A.1 Overview

The Model 986 includes two integrated circuits which provide most of the microcontroller and analog circuit functions.

- All control and display functions are governed by the microcontroller (U1).
- All probe analog data interfacing to the microcontroller is provided by U2. U2 functions as an A/D converter.

Probe resistance measurements are made by taking the ratio of two pulse widths that are generated in U2 by sequentially switching in one calibration resistor and the probe thermistor. These pulse widths are measured by the microprocessor, which calculates the probe resistance. The actual probe temperature is then calculated from the probe resistance.

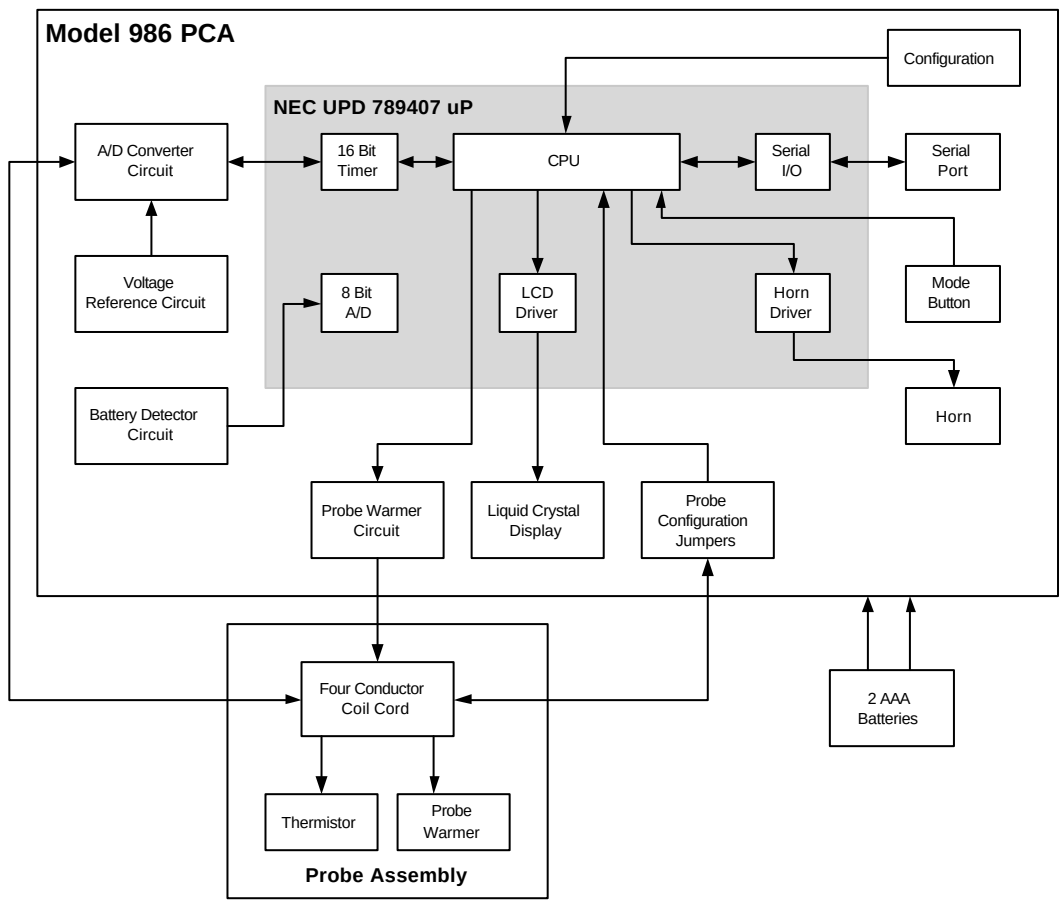

Figure 8: System Block Diagram

A.1.1 Temperature Probes

Model 986 thermometers are configured at the factory for Oral/Axillary or Rectal probe types. The probe type is configured at the factory by the absence or presence of the MODE jumpers JP1 through JP4.

- Axillary temperatures are measured with oral probes in combination with the axillary mode algorithm, and provide a temperature reading in about 10 seconds.
- Rectal temperatures are measured with rectal probes in combination with the rectal mode algorithm, and provide a Normal mode temperature in about 15 seconds.

Model 986 oral probes have a warming resistor in the tip to pre-warm the probe before placement in the mouth, thus speeding typical response.

A.1.2 Probe Switch

The probe shaft activates the probe switch (S1) when the probe is installed or removed from its storage well. Placing the probe into the well pulls microprocessor pin 76 high via an internal pull up resistor. When the probe is removed, this line is pulled low. This signal is also routed to test connector J2 pin 3 to allow automated testing of this function during factory test.

CAUTION: J2 provides a convenient set of test points to monitor proper operation of all user switch functions. BE CAREFUL WITH STATIC DISCHARGE! J2 ties directly to CMOS processor inputs, which are easily damaged by static discharge. Follow proper static handling techniques.

A.1.3 Normal Mode Description

The Oral probe is pre-warmed using a pulse width modulation (PWM) controller to 33.9°C (93°F) upon extraction from the storage well. When the probe is first extracted and colder than 33.9°C, the pulse widths are at a maximum percentage ON vs. OFF to warm the probe quickly. When the probe reaches 33.9°C, the pulse widths narrow to a duty cycle just high enough to maintain temperature.

When the probe is placed in the mouth, the heat supplied by the mouth causes the pulse widths to reduce to zero. This reduction to zero (and the probe being at least up to 33.1°C) triggers the start of the prediction algorithm.

The shape of the rising temperature curve is monitored and the best fit to a curve is found. When the curve fit is stable, the final predicted temperature is displayed.

If the prediction criteria explained above are not met within 15 seconds of starting the prediction process, the instrument will automatically switch to Monitor mode. If the ambient temperature is above 33.9°C (93.0°F) the unit will automatically switch to Monitor mode.

Note: Rectal probes are *not* pre-warmed.

A.1.4 Power Supply

Power is drawn from the two AAA alkaline cells directly to the circuit electronics. The voltage from the batteries is unregulated but filtered by capacitor C25. The power supply voltage will range from about 3.2 volts with new batteries to 2.6 volts at shutdown.

The thermometer has two battery voltage indicators:

- The first is a warning that batteries are getting low (2.8 volts) and is indicated by the battery icon flashing in the display. Accuracy is not affected during low battery warning indication.
- When the batteries fall to approximately 2.6 volts, the dead battery error condition is defined to exist. Operation is halted and the **E2.1** error message is displayed. At this point, the batteries must be replaced and the thermometer electronics reset. See Reset Self/Tests, Operational Checks, and Battery Replacement.

A.1.5 Microcontroller

An NEC UPD789407 single chip microcontroller in a QFP package (U1) is used for signal digitizing, data processing, program memory addressing and storage, and I/O interfacing. The microcontroller also includes an LCD controller/driver that allows internal conversion of CMOS logic levels to a data format capable of driving the Model 986 LCD. In this application, the microcontroller is running at 2.4576 MHz.

A.1.6 Reset/Self Tests

Upon battery installation, (assuming that the electronics have been discharged sufficiently by pressing the **Mode** button with batteries removed) the microprocessor receives a power up reset signal from the components associated with the reset line U1-67. When power is applied continuously, C3 is charged slowly through R7 providing an active low reset to the microprocessor.

When the reset signal is complete, the microprocessor launches a series of self-checks, which include RAM, probe warmer circuitry, probe, battery voltage, and ambient temperature tests. Any failures will cause a specific error code to be displayed.

A.1.7 Microprocessor Clock

The clock for the microprocessor is generated by X1 and capacitors C26 and C27, which form a 2.4576 MHz. oscillator circuit. The microcontroller is running at approximately 2.5 MHz, which is achieved by internally dividing the frequency of oscillation by two.

A.1.8 Temperature Measurement And Display

The thermometer probes incorporate negative temperature coefficient thermistors. When the temperature of the probe is increased, its electrical resistance decreases.

Model 986 uses 20K thermistors, providing a resistance of approximately 20 Kohms at room temperature. At 37°C (patient temperatures) they are near 12 Kohms. The change in resistance is nonlinear with temperature and an equation describing this curve is programmed into the thermometer.

A.2 Temperature Measurement A/D Converter

This section provides a detailed description of the analog hardware implemented in the Model 986.

A.2.1 Use of Analog Circuitry

The primary function of the temperature measurement A/D converter circuit is to convert a measured resistance into a 16-bit word, which is then used by the microprocessor to calibrate itself and calculate a temperature.

A.2.2 A/D Theory of Operation

The A/D circuit is made up of 4 major parts:

- The resistance to be measured (either the probe thermistor or the RATIOCAL resistor)
- The timing capacitor (C21, 0.33uF) and associated driver circuitry (Q1, Q3, Q4, Q9, R15, and R30)
- A low bias current comparator (U2, LMC555)
- A 16 bit timer internal to the microprocessor.

Via software this becomes, in effect, a single slope converter that measures the time constant of the measured resistance combined with a fixed capacitance.

The time constant is measured by counting the time it takes for the voltage to decay from a fixed initial voltage level to a fixed lower voltage. The ratio of this pulse width and the pulse width corresponding to a known calibration resistance (R13, 11.55K) is used to calculate the measured resistance.

Once the resistance is known, the corresponding temperature is calculated using the thermistor temperature equation. Because the M986 uses this 'ratio cal' method for measuring the thermistor resistance, the device is immune to the variability in gain of external hardware devices.

A.2.3 Circuit Description

Initially, the microprocessor simultaneously discharges both sides of the capacitor. This is accomplished by bringing A/D TRIGGER high which turns on Q9 pulling one side of the capacitor (C21) to ground and turns on Q1 and Q3 via PROBE_SEL, and RATIOCAL_SEL which allows the other side to discharge through the thermistor, and R13 (11.55K).

Once the capacitor has been fully discharged, the RATIOCAL resistor is then selected by switching the probe resistor path off. The microprocessor then forces the A/D TRIGGER signal to go low, turning on Q4, which lifts one end of the capacitor up to VREF (1.8V). Because there can be no instantaneous voltage drop across the capacitor, the other side of the capacitor immediately goes to 1.8V. This exceeds the threshold voltage (1.2V) of U2 (LMC555), causing the output A/D_OUT to go low.

At this point, the capacitor begins to discharge from 1.8 V to 0V through the RATIOCAL resistor. The output of the comparator goes high again when its input reaches the trigger voltage (0.6 volts). This produces a pulse of length equal to the time it takes for the capacitor to discharge from 1.8V to 0.6V through the RATIOCAL resistor.

The microprocessor measures this pulse width using a firmware implemented 16-bit timer and then after repeating the capacitive discharge cycle, the same A/D conversion is performed using the probe resistor as the measured resistance. The microprocessor performs the following calculation that ratios these two pulse widths to determine the exact resistance of the thermistor:

$$\mathrm{Rthermistor} = \frac{(\mathrm{PWthermistor}) \cdot (\mathrm{Rhical})}{\mathrm{PWhical}}$$

The microprocessor then uses the following equation to convert the measured resistance into a temperature:

$$\mathrm{Temperature_in_Kelvin} = \frac{1}{\mathrm{Ra} + \mathrm{Rb} \cdot \ln(\mathrm{Rt}) + \mathrm{Rc} \cdot \ln(\mathrm{Rt})^3}$$

A.2.4 Probe Type Detection

Upon power reset, the thermometer performs a probe test. Probe type is first detected and then, if it is an oral probe, its warming characteristics are determined. Rectal probes are not warmed, so warming characteristics are not tested on these probes.

A.2.5 Instrument ID Logic

The instrument logic is used to determine the type of probe the thermometer is configured for (Oral/Axillary or Rectal). This allows the microprocessor to initiate the proper algorithm for converting a thermistor measurement into a temperature. The configuration truth table is listed below.

Table 4: Configuration Truth Table

Zero Ohm Resistor to be Installed at:							
JP1	**JP2**	**JP3**	**JP4**	**JP5**	**JP6**	**CNFG#**	**Configuration**
Y	Y	Y	Y	Y	Y	-0000	ORAL
Y	Y	Y	N	Y	Y	-0001	RECTAL
Y	Y	Y	Y	Y	N	-0002	INT'L
Y	Y	Y	N	Y	Y	-0003	VET
N	Y	Y	Y	Y	N	-0004	ORAL, JAPAN
Y	Y	Y	N	Y	N	-0005	INT'L, RECTAL
N	Y	N	N	Y	N	-0006	RECTAL, JAPAN
Y	Y	Y	N	Y	N	-0007	INT'L VET

A.2.6 Circuit Operation

Jumpers JP1 through JP4 are used to provide logic 0 or 1 inputs to U1-27, 28, 29 and 30 depending on what probe and algorithm the instrument was configured with at the factory. When a probe has been connected, the software determines what algorithm to use based on the jumper connections listed above.

A.3 Probe warming (Oral probes only)

The probe warmer circuitry is used to heat the probe tip prior to taking a temperature reading in order to speed the convergence of the prediction algorithm. This allows quicker temperature readings. A fail-safe hardware shutoff circuit is included to ensure the heater will shut off in the event of a software failure.

A.3.1 Theory of Operation

The microprocessor sends pulses via HTRC to drive the probe heater resistor, which heats the probe tip. A temperature of about 93°F is maintained prior to taking a patient temperature.

Software has a built in algorithm that determines the width of the HTRC pulse, which varies depending upon the temperature of the probe. It provides an initial pulse to rapidly heat up the probe tip to the 90°F region and then supplies progressively shorter pulses as the probe temperature converges to about 93°F. Once 93°F is reached, software continues to send a control pulse, which maintains the temperature.

A.3.2 Circuit Operation

The warmer circuitry consists of Q5, Q13, Q14, C1, C2, L1, D1, R1, R2, R3, R4, R5, R31, R32, along with the heater resistor inside the probe (27 ohms) connected across J1-3 and J1-4.

/HTRQ is pulled low by the microprocessor, which enables Q13 to turn on. /HTRC is then pulled low, which brings the base of Q5 low, which in turn drives the base of Q14 low. Since Q14 E and B are pulled near the positive rail and Q5 E and B are pulled near the negative rail, the base current from Q14 flows through R31 (1K) and R32 (1K).

This current flows through the emitter of Q5. The base current of Q5, along with the current through R1 (3M) flows in to C1 (1uF), charging it up. This sets up the mechanism for the hardware to shut off. As this capacitor charges up, the base voltage of Q5 approaches the emitter voltage and the transistor shuts off, thereby shutting down the probe warmer.

As long as Q5 remains on, Q14 has a base current flowing which allows current to flow from its collector through R2 (4.7K) and the heater resistor. With about 122mA flowing through it (VCC-2VCEsat)/26 ohms), the heater resistor heats up the probe tip.

During normal operation, software turns the warmer circuit on and off. The width of the pulse on /HTRC determines how long Q5 is turned on, thereby determining how long the heater is heating. Once the /HTRC pulse goes high again, the base of Q5 is pulled high turning it off, and the capacitor discharges to VCC through D1.

Q13 and Q14 are selected for their low saturation on voltage. D1 is a diode clamp used to keep the base of Q5 from attaining a much higher voltage than VCC. R4 (47K) and R2 (4.7K) in combination with R3 (47K) serve as pull-down resistors, ensuring that the processor feedback lines (U1-43 and U1-44) go low immediately upon warmer component shutoff. C2 serves as an RFI suppression component.

A.3.3 Liquid Crystal Display

The model 986 uses a transreflective liquid crystal display to display data to the user. Three common lines and 12 segment lines connect the LCD to the display driver (U1-7 to U1-22) internal to the NEC microprocessor. The LCD is 3:1 multiplexed with 1/2 bias. The bias voltages (1.0 volts, and 2.0 volts) are supplied to the display driver by the voltage reference circuit

The LCD glass is electrically tied to the display PCB via an elastomeric connector sandwiched and compressed between the glass and the PCB by the frame. This assembly, if taken apart, cannot be reassembled without replacing the frame.

A.3.4 Probe Switch

When the probe has been inserted in the probe holder, the probe switch (S1) brings PROBE SW (U1-75) high (VCC). When the probe is removed from the probe holder, the probe switch brings PROBE SW (U1-75) low (GND).

A.3.5 Mode Button

The **Mode** button (P2) is a momentary contact switch.

- A pull up internal to the microprocessor normally pulls /MODE (U1-76) high, placing a logic “1” at this input.
- When depressed, P2 provides a momentary contact to ground at MODE giving it a logic level of “0”.

The software continuously checks MODE. If the thermometer is not in the process of taking a temperature, pressing the **Mode** button will wake up the thermometer and display the last recorded temperature.

A.3.6 Horn

The horn is activated at the start of a temperature taking cycle, at the end of a Normal mode temperature cycle, and for various error conditions.

- A short duration high pitch single beep indicates normal operation.
- A long duration beep, approximately one second, indicates errors such as temperature out of range during a temperature measurement cycle.

The horn (LS1) is a miniature piezoelectric speaker with a resonant frequency of 2 kHz driven by processor square wave. The horn control signal comes from U1 pin 50 to produce the audible tones.

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Appendix B. Specifications

Dimensions (nominal)	2.3 in. W, 6.6 in. H, 1.9 in D 5.8 cm W, 16.8 cm. H, 4.8 cm. D (with probe cover storage)
Case Material	ABS Plastic.
Weight (nominal)	6.0 ounces (171 grams).
Ambient Temperature Range	9.0° C to 40.0° C (48.2° F to 104.0° F).
Patient Temperature	
Oral/Axillary	The patient temperature range is 35.5° C to 43.0° C (96° F to 109.4° F).
Rectal	The patient temperature range is 30.0°C to 43.0° C (86° F to 109.4° F).
Laboratory Accuracy	± 0.1° C (± 0.2° F) in the Monitor Mode and in a water bath meets the ASTM E1112-86 and EN12470-3 Standards.
Mode Button	Selects °F/ °C. Oral and Axillary Modes
Probe Types	Factory set to either: Oral/Axillary or Rectal.
Power Source	Two “AAA” alkaline batteries.
Battery Operating Life	Approximately 3,000 normal temperature measurements at 72° F ambient temperature.
Display Type	Liquid Crystal Display, 3.5 digits plus special icons.

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Appendix C. Limited Warranty

1-YEAR LIMITED WARRANTY ON NEW M986 INSTRUMENTS

Instrumentation purchased new from Welch Allyn, Inc. is warranted to be free from original defects in material and workmanship under normal use and service for a period of one year from the date of first shipment from Welch Allyn. This warranty shall be fulfilled by Welch Allyn or its authorized representative repairing or replacing at Welch Allyn's discretion, any such defect, free of charge for parts and labor.

Welch Allyn should be notified via telephone of any defective product and the item should be immediately returned, securely packaged and postage prepaid to Welch Allyn. Loss or damage in shipment shall be at purchaser's risk.

Welch Allyn will not be responsible for loss associated with the use of any Welch Allyn product that (1) has had the serial number defaced, (2) has been repaired by anyone other than an authorized Welch Allyn Service Representative, (3) has been altered, or (4) has been used in a manner other than in accordance with instructions.

THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ANY IMPLIED WARRANTY OR MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE, OR OTHER WARRANTY OF QUALITY, WHETHER EXPRESSED OR IMPLIED. WELCH ALLYN WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

The information in this manual has been carefully reviewed and is believed to be accurate; however, no responsibility is assumed for inaccuracies. Furthermore, this information does not convey to the purchaser of Welch Allyn devices, any license under the patent rights to the manufacturer.

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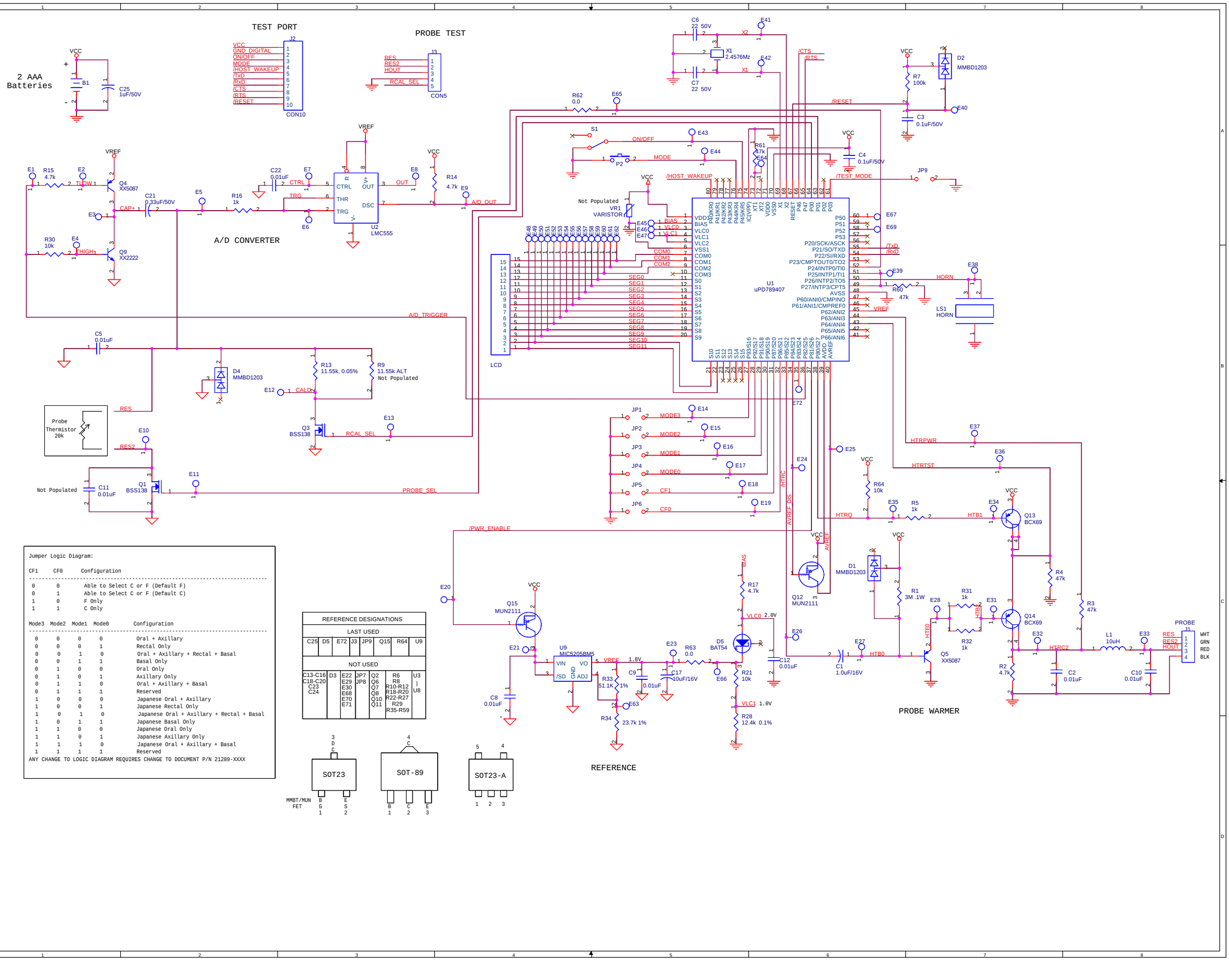
TEST PORT
PROBE TEST
2 AAA Batteries
VCC
B1
C25 1uF/50V
J2
VCC
GND_DIGITAL
ON/OFF
MODE
/HOST_WAKEUP
/TxD
/RxD
/CTS
/RTS
/RESET
CON10
J3
RES
RES2
HOUT
RCAL_SEL
CON5
C6 22 50V
C7 22 50V
X1 2.4576Mz
E41
E42
/CTS
/RTS
D2 MMBD1203
R7 100k
E40
C3 0.1uF/50V
/RESET
R62 0.0
E65
S1
ON/OFF
P2
MODE
E43
E44
R61 47k
E64
C4 0.1uF/50V
/TEST_MODE
JP9
VREF
E1
R15 4.7k
E2
TLOW
Q4 XX5087
C21 0.33uF/50V
CAP+
E3
R30 10k
E4
THIGH
Q9 XX2222
E5
R16 1k
C22 0.01uF
E7
CTRL
TRG
E6
U2 LMC555
E8
R14 4.7k
E9
A/D_OUT
A/D CONVERTER
/HOST_WAKEUP
Not Populated
VR1 VARISTOR
E45
E46
E47
BIAS
VLC0
VLC1
LCD
COM0
COM1
COM2
COM3
SEG0
SEG1
SEG2
SEG3
SEG4
SEG5
SEG6
SEG7
SEG8
SEG9
SEG10
SEG11
U1 uPD789407
P50
P51
P52
P53
P20/SCK/ASCK
P21/SO/TXD
P22/SI/RXD
P23/CMPTOUT0/TO2
P24/INTP0/TI0
P25/INTP1/TI1
P26/INTP2/TO5
P27/INTP3/CPT5
AVSS
P60/ANI0/CMPINO
P61/ANI1/CMPREF0
P62/ANI2
P63/ANI3
P64/ANI4
P65/ANI5
P66/ANI6
AVREF
E67
E69
/TxD
/RxD
E39
HORN
R60 47k
E38
LS1 HORN
VREF
A/D_TRIGGER
C5 0.01uF
D4 MMBD1203
R13 11.55k, 0.05%
R9 11.55k ALT Not Populated
E12
CALDS
Q3 BSS138
RCAL_SEL
E13
RES
Probe Thermistor 20k
E10
RES2
Not Populated
C11 0.01uF
Q1 BSS138
E11
PROBE_SEL
JP1
JP2
JP3
JP4
JP5
JP6
MODE3
MODE2
MODE1
MODE0
CF1
CF0
E14
E15
E16
E17
E18
E19
E72
E24
E25
HTRPWR
HTRTST
E37
E36
R64 10k
E35
R5 1k
E34
Q13 BCX69
HTRQ
HTB1
/PWR_ENABLE
AVREF_DIS
HTRC
AVREF
Q12 MUN2111
D1 MMBD1203
R1 3M .1W
R31 1k
R32 1k
E28
E31
HTB2
HTE0
HTB0
Q5 XX5087
R4 47k
R3 47k
E32
HTRC2
L1 10uH
E33
C2 0.01uF
C10 0.01uF
PROBE
RES
RES2
HOUT
WHT
GRN
RED
BLK
PROBE WARMER
E20
Q15 MUN2111
E21
U9 MIC5205BM5
VIN
VO
/SD
GND
ADJ
VREF
1.8V
C8 0.01uF
C9 0.01uF
R33 51.1K 1%
R34 23.7k 1%
E63
E23
R63 0.0
C17 10uF/16V
E66
D5 BAT54
R17 4.7k
VLC0 2.0V
R21 10k
VLC1 1.0V
R28 12.4k 0.1%
C12 0.01uF
E26
C1 1.0uF/16V
E27
REFERENCE
Jumper Logic Diagram:
CF1 CF0 Configuration
0 0 Able to Select C or F (Default F)
0 1 Able to Select C or F (Default C)
1 0 F Only
1 1 C Only
Mode3 Mode2 Mode1 Mode0 Configuration
0 0 0 0 Oral + Axillary
0 0 0 1 Rectal Only
0 0 1 0 Oral + Axillary + Rectal + Basal
0 0 1 1 Basal Only
0 1 0 0 Oral Only
0 1 0 1 Axillary Only
0 1 1 0 Oral + Axillary + Basal
0 1 1 1 Reserved
1 0 0 0 Japanese Oral + Axillary
1 0 0 1 Japanese Rectal Only
1 0 1 0 Japanese Oral + Axillary + Rectal + Basal
1 0 1 1 Japanese Basal Only
1 1 0 0 Japanese Oral Only
1 1 0 1 Japanese Axillary Only
1 1 1 0 Japanese Oral + Axillary + Basal
1 1 1 1 Reserved
ANY CHANGE TO LOGIC DIAGRAM REQUIRES CHANGE TO DOCUMENT P/N 21289-XXXX
REFERENCE DESIGNATIONS
LAST USED
C25 D5 E72 J3 JP9 Q15 R64 U9
NOT USED
C13-C16 C18-C20 C23 C24 D3 E22 E29 E30 E68 E70 E71 JP7 JP8 Q2 Q6 Q7 Q8 Q10 Q11 R6 R8 R10-R12 R18-R20 R22-R27 R29 R35-R59 U3 | U8
SOT23
MMBT/MUN FET
SOT-89
SOT23-A

Welch Allyn, Inc.
7420 Carroll Road
San Diego, CA 92121
(800) 535-6663